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FISH FARMING IN FINLAND

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In S. Salonen (ed.): Vesiston kuormituksen vahentaminen kalanviljelyssa. Kuopion korkeakoululla vesitutkimuspaivana 13.10.1983 pidetyt esitelmat. (Reduction of the pollution effects of fish farming on water systems. Collected papers from the Water Research Day, 13 October 1983, University of Kuopio)

At the end of 1981, there were 338 fish farms in Finland, not including ponds operating on natural nutrition. Of this total, 253 were in inland water areas and 85 in marine areas. 5*

There were 242 facilities specializing in the production of food fish, most frequently rainbow trout. Of these, 157 were in inland waters and the rest in marine areas. All of the seawater facilities used in net cages or enclosures. The inland facilities mostly use earthen ponds. The production percentage of seawater farms was 41% in 1981.

*The numbers in the right-hand margin indicate the corresponding page numbers in the original. Translator's note.

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Rainbow trout culture in Finland has increased as follows:

Year	Production (t/year)
1975	1 800
1976	2 500
1977	3 000
1978	3 205
1979	3 275
1980	4 670
1981	5 383
1982	6 500 (arvio)(estimate)

Most of the rainbow trout produced in Finland is for the domestic market, although an effort has been made in the recent past to develop exports as well.

Fish farms in Finland are situated almost exclusively along river systems, and most of the marine facilities are in the Turku archipelago. A few river systems suitable for fish farms, at least for small facilities, still remain but they are subject to other pressures of use as well. An effort is being made in regions such as Kainuu and the county of Kuopio to map out areas suitable for fish farming. It may in the future be possible to establish facilities in the form of pump stations along lake systems as well, and recirculation stations may also be relatively independent of the structure of the water system.

PRODUCTION IN OTHER COUNTRIES

Of the Scandinavian countries, Denmark has the longest tradition in food fish culture. Danish rainbow trout production is today about 18,000 tonnes/a, and it is growing slowly if at all. The minimum size of a profitable facility in Denmark is estimated to be about 40 t/a. Denmark, similarly to other countries producing rainbow trout - with the exception of Finland and Norway - produces so-called pan-fry fish, whose production cycle is about one year. (The production cycle in Finland and Norway is about 3 years, although efforts are being made to shorten it).

Fish farming in Sweden is the least extensive in Scandinavia. Rainbow trout production in 1980 was estimated to be 1000 tonnes. The whole field of aquaculture is entering rapid development in Sweden, and it is also being supported by coordinated public measures. 6

Norway estimates its 1982 production as 15,000 tonnes of salmon and 4,700 tonnes of rainbow trout. The combined production objective of 1986-87 is 60,000 tonnes.

In addition to Scandinavia, the leading countries of food fish production are Italy and France in Europe and countries such as the United States and Japan outside Europe.

FISH FARMING IN THE FINNISH ECONOMY

Fish farming in Finland produces brood stock, spawn, stocking fingerlings and food fish for direct consumption. The value of rainbow trout supplied as food fish was 116.8 million marks in 1981, which was about 25% of the total value (473 million marks) of our fishing and fish farming harvest. The value of commercial fishing was 174 million marks, which includes marine fishing. The share of rainbow trout was 40% of the value of the industrial harvest (291 million marks).

Fish farming operations are largely based on dry feed manufactured commercially. There are four feed manufacturers in our country and a fifth one is starting. Two of the manufacturers produce feed developed domestically, the others produce their feed under a foreign licence. No problems have been experienced in feed availability.

In addition to dry feeds, wet feed is also used, which may be significant in marine areas in particular. Fresh fish is used as feed especially by fish-farming fishermen who can in this manner take advantage of the feed potential of their Baltic herring harvest. The semimoist pellet, i.e. pelleted wet feed, is an intermediate form between wet feed and dry feed. Gutting waste or similar materials can be particularly appropriately utilized for this purpose.

Both the growth rate and the efficiency of feed have improved considerably in rainbow trout production since the start of rainbow trout farming in Finland. The conversion factors of dry feed are at the moment in the range of 1.0...1.8, having been less favourable, i.e. 2...3 during the beginning of operations. The phosphorus content of feed has been reduced from 1.5% to 0.7% as part of feed development and this has had beneficial environmental effects.

About 15 million kg of dry feed was used in 1982. Using 3.60 Marks/kg as the average price, total feed costs are calculated to be 54 million marks.

The number of workers in the field is estimated to be 700 individuals, and labour costs 42 million marks. The monetary value of rainbow trout production was about 170 million marks, estimated on the basis of quantities produced in 1982. Almost all production facilities are situated in sparsely populated and developing regions. The multiplier impact of fish farming in terms of employment falls on sectors such as feed manufacturing, transportation, fish trade, planning and construction, equipment suppliers and tourism. 7

FISH FARMING AND WATER POLLUTION CONTROL

Attention has been paid to the environmental effects of fish farming in all the countries where it is practiced. Intensive research and development in the field is being carried out in countries such as Denmark and Finland although the problems of these two countries are different: solid matter producted by the facilities and provision of good-quality water in adequate quantities often cause problems in Denmark; Finland on the other hand concentrates on the eutrophying effects of phosphorus (P) and nitrogen (N) downstream.

We have three possible sectors for research and development when developing measures for water pollution control in fish farming. I will briefly list these sectors in the following and introduce possible areas of research and development. This list is naturally not absolutely complete but it is probably nevertheless largely representative of our current know-how.

1) Water pollution control through the development of production techniques and as their "by-product":

- Feed: quantity & quality: improvement and optimization of the feed conversion factor and its adjustment to the growth physiology of fish.
- Feeding technique: reduction of feed waste, reduction of labour costs.
- Rearing technique and structures in particular:
  - self-cleaning structures
  - otherwise easily cleanable, taking into account the comfort of the fish
  - renovation of existing facilities and development of a technique suited to them
- Recirculation stations

- Monoculture vs. polyculture: it may also be possible to achieve a more effective use of nutrients by raising several species either in the same location or in succession.

2) Water pollution control through direct measures:

- Sludge removal technology
- Partially or completely self-cleaning structures
- Hydroclones
- Sedimentation basins
- Binding of nutrients with the biomass, changing of the nutrient balance through the effect of a biomass filter
- Site selection of facilities to minimize environmental effects

3) Effects of fish farming on the downstream water system:

- Estimating the effect in relation to the actual damage.
- Correlation of the effects and the damages from fish farming to other operations causing pollution, incl. the general industrial policy.
- Correlation of the effects and the damages to the character and functioning of the downstream water system; for instance, the N/P/C ratio is important in terms of functioning.
- Short-range (year) and long-range (decade, etc.) dynamics of the effects: the downstream water system generally resists pressure to change.
- The general characteristic of the inland waters of forming chains has an effect on the site selection and on the effects of the facility. The nutrient dynamics as well as the effects may change considerably in connected lakes.

As to their internal operations, Finnish fish farms are both similar and dissimilar, although our knowledge of station operations and their effects on nutrient discharges etc. is still lacking in detail. The uniqueness of the facilities means that sludge removal techniques, etc. must be "custom-made" for each facility, and there is probably no technical cleaning "kit" that would suit all facilities as is.

It should be remembered when the cleaning technology is developed and applied in practice that all of the three sectors mentioned above have an effect on its optimization: production technology as such, special measures to control water pollution, and the character and functioning of the downstream water system and any damage caused by a higher nutrient content channelled through it. When planning for special measures, we must therefore also keep in mind the comprehensive setting, in which economy has a central and important role: the investments must be reasonable in relation to the desirable and achieved results in water pollution control.

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